Pennsylvania Railroad, Altoona Works
East side of Chestnut and 10th avenues,
between 6th Street North and 16th Street South
Altoona
Blair County
Pennsylvania

HAER No. PA-108

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

Historic American Engineering Record
National Park Service
Department of the Interior
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HISTORIC AMERICAN ENGINEERING RECORD

PENNSYLVANIA RAILROAD, ALTOONA WORKS

HAER No. PA-108

Location: East side of Chestnut and 10th avenues, between 6th Street North and 16th Street South, Altoona, Blair County, Pennsylvania

USGS Quad: Altoona, Pennsylvania (1:24000)

Date of Construction: 1854-1925

Builder: Pennsylvania Railroad

Present Owner: Conrail and other private industries

Present Use: Manufacturing and Testing of Railroad Rolling Stock

Significance: The Altoona Shops of the Pennsylvania Railroad were the largest railroad-owned construction shops in the country and had been the training ground for many American railroad builders and engineers. The Altoona Shops pioneered in the standardization of the railroad industry, establishing standard car designs, standard locomotive classes and standard product specifications. The first railroad test department was also initiated here in 1874.

Project Information: In February 1987, the Historic American Engineering Record (HAER) and the Historic American Buildings Survey (HABS) began a multi-year historical and architectural documentation project in southwestern Pennsylvania. Carried out in conjunction with America's Industrial Heritage Project (AIHP), HAER undertook a comprehensive inventory of Blair and Cambria counties as the first step in identifying the region's surviving historic engineering works and industrial resources.

The results of this project have been published in Blair County and Cambria County, Pennsylvania: An Inventory of Historic Engineering and Industrial Sites (1990), edited by Gray Fitzsimons and produced by HABS/HAER for the National Park Service. Information on specific sites within the Pennsylvania Railroad's Altoona Works can be found in the above-cited publication or in the following files:

HAER No. PA-228	East Altoona Freight Locomotive Terminal
HAER No. PA-229	Alto Tower
HAER No. PA-230	Altoona Car Shops
HAER No. PA-231	Twelfth Street Car Shops
HAER No. PA-232	Juniata Shops

Compiler: Peter Stott, Historian
Gray Fitzsimons, Editor

History:

1854-1925: Development of the Pennsylvania Railroad's Altoona Works

In the twentieth century, the Pennsylvania Railroad often promoted itself as the "Standard Railroad of the World." Among its many achievements, it could claim, in 1945, over 16 per cent of all passenger miles in the U.S. It was among the first to use coal-burning locomotives, steel rails, and air brakes; and its Altoona shops, the largest railroad-owned construction shops in the country, had been the training ground for many American railroad builders and engineers.[1] The company saw itself as setting the "standard" by which all railroads should be run and against which all railroads might be measured. In another sense, however, the railroad, particularly in its shops at Altoona, pioneered in standardization itself. At Altoona, the railroad introduced standard car designs in 1859, standard locomotive classes in 1868, and, with the establishment of the first railroad test department in 1874, standard product specifications. These factors played an important role in the growth of the railroad as a whole, as well as in the evolution of the Altoona works from a random collection of small shop buildings to a carefully organized production facility. This essay examines the development of the Altoona Works between 1854 and 1925, when the last major shop facility was constructed.

1846-1874: J. Edgar Thomson and the Creation of the PRR

The Pennsylvania Railroad was organized in 1846 to provide a through route from Philadelphia to the Ohio River. Its guiding spirit, initially as its chief engineer, and then as its president from 1852 until his death, was J. Edgar Thomson (1808-1874).[2] Altoona was Thomson's choice as the site of the PRR's principal locomotive and repair facility. Thomson chose Altoona on the theory that the heavy work of crossing the Alleghenies should be concentrated into a reasonably short distance of relatively steep grades, rather than spread out over much longer grades of less elevation, but which required heavy and expensive cuts, tunnels, and viaducts. At Altoona, extra locomotive power could be added in order to accomplish the summit.[3] The 12-1/4-mile run to the summit was up a continuous gradient of 80 feet per mile--less, Thomson noted than, the maximum used on either the Boston & Albany Railroad or the Baltimore & Ohio.[4]

Land for the shops was purchased at what was known as Robinson's Ridge in 1849, and the first shops were laid out by one of the Thomson's assistants, Strickland Kneass (1821-1884), a Rensselaer Polytechnic Institute (RPI) graduate who had worked under Schlatter on the first survey for a state railroad a decade before.[5]

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[1]George H. Burgess and Miles C. Kennedy, Centennial History of the Pennsylvania Railroad Company, 1846-1946 (Philadelphia: Pennsylvania Railroad Company, 1949), pp. 732-3; J. Elfreth Watkins, History of the Pennsylvania Railroad Company, 1846-1896 (Philadelphia, 1896), p. 336.

[2]For biographical material on Thomson see James Arthur Ward, J. Edgar Thomson: Master of the Pennsylvania (1980).

[3]Thomson's was not the only view, however. In part, he was rejecting an earlier survey by state engineer Charles Schlatter. In Schlatter's survey for a state railway between Harrisburg and Pittsburgh, conducted between 1839 and 1842, no grades exceeded 45 feet per mile. But to accomplish this, he had many grades of that magnitude, and in order to cross the divide, it was necessary to approach the mountains at a considerable elevation, requiring expensive cuts, tunnels, and viaducts.

[4]First Annual Report of the Board of Directors of the Pennsylvania Railroad Company [hereafter, PRR Annual Report] (10/30/1847).

[5]Kneass has also been credited with laying out the road from Altoona to the summit, including Horseshoe Curve, though Samuel W. Mifflin (1808-1888), and George Leuffer (1814-1899) are also names that are given that honor (See "Strickland Kneass," Dictionary of American Biography, Vol. 5, pp. 455-456; "Samuel W. Mifflin," Railroad Gazette 17 (21 August 1885), p. 541; "George Leuffer," Engineering Record 40 (22 July 1899), p. 182.).

The shops were designed for new car construction, as well as for repairs to cars and locomotives. Superintendent of Transportation, Herman Haupt explained the reasoning for new car construction:

> Our experience thus far has demonstrated that cars can be built cheaper and better by the company than by contract. The location in Altoona is particularly eligible, and it will be to the interest of the company to concentrate the work as much as possible at this point.[6]

A year later (February 1853) the directors reported that:

> Repairing of cars, formerly done at Harrisburg, is now done at Altoona, where arrangements are partially perfected; and the introduction of more tools and manufacturing at that point, will enable us to proceed rapidly with the building of new cars and duplicate parts of locomotives. The foundry there is in full operation, making the castings for all our shops, except the West Philadelphia Repair Shop.[7]

By the time the main line opened in 1854, the shop buildings consisted of a half-round car erecting shop (on the site of the present Erecting Shop No. 3), and a long, one-story building with wing, extending west from Twelfth Street. The latter building housed a locomotive erecting shop and such ancillary facilities necessary including foundry, blacksmith, machine, wood-working, and paint shops necessary to support the locomotive and car work.[8] The same year, a new 26-engine roundhouse was constructed, and a new erecting shop was to be ready in the spring of 1855. By the end of 1855, the shops had already reached sizable proportions, and were equipped to do almost any kind of work. The PRR at that date operated 115 freight and passenger locomotives. Passenger cars, numbering ninety-seven, consisted of thirty-six "wide" cars for most of its routes, thirty-four "narrow" cars for use on the Philadelphia & Columbia Railroad (whose tracks were too close to allow the wider PRR cars), and twenty-seven "immigrant" cars. Freight cars numbered over 1500, of which 70% were the eight-wheeled "house" (or box) cars.[9]

An important stimulus to PRR development was its purchase in 1857 of the state-owned Pennsylvania Canal and its connecting railroad, the Philadelphia & Columbia.[10] Built in 1834 to connect Philadelphia with the terminus of the mainline canal at Columbia, the 82-mile long railroad added nearly 100 locomotives to the PRR's existing stock. A similar increase in cars meant that demands on the repair facilities grew dramatically. The shops were considerably enlarged at this time.

A significant aspect of the state acquisition was the introduction of standardized car design. The Philadelphia and Columbia utilized a car size smaller than that on the main line, and it must have been this that impressed upon Ambrose Ward, the General Foreman of the Car Department, to introduce a "uniform standard of pattern" for the Car Department at all the shops. Ward wrote in the annual report for 1859:

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[6] 5th PRR Annual Report (2/2/1852), p. 66.

[7] 6th PRR Annual Report (2/7/1853).

[8] Altoona Charter Centennial (Altoona: Altoona Charter Centennial Committee, 1968), p. 19.

[9] 8th PRR Annual Report (1/31/1855), p. 5, 51.

[10] The acquisition was intended as part of a deal with the State of Pennsylvania: in return for taking over the state's money-losing transportation system, the state would repeal the tax on railroad tonnage. But the state reneged on the deal, and the tonnage repeal was not enacted until the mid 1860s.

> This arrangement I consider of much importance, as it will enable us to get our entire equipment in each class uniform, and thus dispense with the necessity of keeping such a large variety of patterns and duplicate work on hand for repairs.[11]

Standardized parts moved the Altoona shops closer toward interchangeability, an important factor in converting what was in many respects still a skilled craft to a modern production line. In the late 1850s, few special-purpose machines existed. Instead, general-purpose wood and metal-working machines were used for whatever job was at hand. As a consequence, all parts entering into the repair of locomotives or cars were shaped and fitted by hand and eye, requiring patience, as well as skilled craftsmanship.[12] Interchangeable parts were virtually unknown, although an effort at standardization existed in "indexing," using wooden templates or sticks as primitive gauges. Materials were carried by hand or sometimes on narrow-gauge tracks through the shops, frequently held up by some obstruction on the shop floor. The overhead crane was as yet unknown here.

The 1860s were a critical period for the PRR, and some of the most radical changes took place during this decade. Coal, first used by the railroad on an experimental basis in 1853, came into full use by all freight locomotives by 1862, and by all others in 1864. Steel rails, introduced in 1864, were rapidly adopted for the entire system. In 1860, despite the movement toward interchangeability begun in the car department, the company still acted on a job-by-job basis. Functions shifted around the yard as space was made available, not for any rational scheme of movement: in 1861 the building used as a passenger car shed was altered for use as a freight car repair shop; in 1863 the eastern section of the main shop, formerly used for passenger car repairs, was added to the machine shop, and passenger car repairs were moved into a southern wing.

Despite the war, the company saw a great increase in eastbound traffic as the European demand for breadstuffs grew due to the closing of the Mississippi. In addition to the increasing traffic, the system mileage also greatly increased, as additional lines were leased or purchased. This increase brought new equipment along the line, and numerous physical changes to the Altoona shop complex. The machine shop received an addition in 1864, and in 1865 a brick blacksmith shop (274' x 60') and wood-frame freight car repair shop (210' x 90') were erected. Superintendent Laird wrote in February 1865, that the addition of 100 locomotives without a corresponding increase in yard room had seriously hampered his work; he strongly recommended that another roundhouse be constructed.[13] His request was granted and in 1867-68, the largest of the new buildings, the 300-foot Western Roundhouse for Pittsburgh Division engines, was constructed.

Locomotive design and construction were also undergoing transformation. Like the Car Department, the Motive Power Department had also had its share of non-PRR transfers from the Philadelphia & Columbia in 1857. Unlike the practice in the car department, however, all of the company's early locomotives were the products of commercial locomotive builders, like Norris or Baldwin of Philadelphia, who were the railroad's principal suppliers in its early years. The Baldwin Locomotive Works, whose founder Matthias W. Baldwin (1795-1866) was a prominent stockholder in the line, was the PRR's largest supplier for much of this early period: in 1857, 99 of the company's 216 engines were Baldwin built.[14] Even with engines from the same builder, interchangeability was rare, and fitting was inevitably required. John P. Laird,

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[11] 12th PRR Annual Report (2/7/1859), p. 37.

[12] Alfred W. Bruce, The Steam Locomotive in America: Its Development in the Twentieth Century (New York: W.W. Norton & Co., 1952), p. 52.

Superintendent of Motive Power between 1862 and 1866, following Ward's work in the Car Department, began the process of rebuilding older locomotives, bringing in standard parts and designs wherever possible.[15]

Altoona began producing its own locomotives in 1866. It is tempting to speculate that the wresting of some production from Baldwin may have been facilitated by the death of the founder and PRR shareholder Matthias Baldwin in 1866. However, a reading of the annual reports seems to suggest that the move toward new construction was gradual. In reporting the output of the shops in the early 1860s, the reports list the number of "locomotives rebuilt entirely new." This expression may reflect how Altoona came to enter the locomotive construction business: not by any conscious decision, but as an extension of its repair business. Perhaps by 1866, repairs had become so complete, replacing so much material that the rebuilt engines were considered "new." In any case, with this repair experience, it would be a short step to building new engines from scratch.

It was not until Andrew J. Cassatt was appointed Superintendent of Motive Power in 1867 that the first complete series of "standard locomotive" drawings, for eight distinct classes of locomotives, was produced. A. J. Cassatt (1839-1906) is best known for his term as president of the road, 1899-1906. Graduated from RPI in 1859, in 1861 he entered the service of the Pennsylvania Railroad as a rodman, becoming successively assistant engineer, resident engineer of the road's Middle Division in 1864, and Motive Power Superintendent in 1867. The man Cassatt made responsible for the standard designs was John B. Collin (1830?-1886), Mechanical Engineer between 1866 and his death in 1886. With very few exceptions, all motive power built after 1867 conformed to the railroad's standard designs. By 1873, of the 873 locomotives in service, 373, or 42.7 percent, were classed as "standard."[16]

Under the impetus of this new work, special-purpose machinery was introduced into the shops. In 1870, a correspondent for the *Baltimore Sun* described the shops:

> Improved machinery for doing almost every character of work is in operation, including some not often found in the shops of other railroads. The riveting of the boilers, for the locomotives for instance, is nearly all done by a powerful riveting machine, driven by steampower. Two small stationary engines are now being built for pumping gas into cylindrical tubes, to be used on passenger trains instead of oil lamps.[17]

As the traffic and rolling stock expanded, it became increasingly difficult to handle railroad repair, maintenance, and storage in the yard. In 1869, Cassatt called for the establishment of a separate location for the car shops:

(Continued)

[15]18th PRR Annual Report (2/21/1865), p. 33.

[14]The Norris Locomotive Works had supplied another fifty-four, with smaller numbers from Lancaster, Smith & Perkins, Ross Winans, Wilmarth, and New Jersey Locomotive & Machine. (Burgess, p. 712; John H. White, Jr., A Short History of American Locomotive Builders in the Steam Era (Washington, D.C.: Bass Inc., 1982), p. 13.).

[15]Paul T. Warner, Motive Power Development on the Pennsylvania Railroad System 1831-1924 (Philadelphia: Baldwin Locomotives, 1924), p. 22.

[16]Warner, pp. 28; Another event of 1868 with a direct bearing on standard locomotive classes was the founding of the American Railway Mechanics Association. One of the organisation'e major objectives was the etandardisation of motive power. (See Bruce, p. 34.)

[17]Quoted in the Altoona Tribune, 29 June 1870, p. 2.

> The motive power and shops during the year [1868] were taxed to their full capacity, and although they were able to meet all demands made upon them, it has become evident that additional facilities will be required at Altoona to provide for rapidly increasing business. These additional facilities would be furnished by the erection of new car shops at that place, when the room now occupied for that work could be made available for the locomotive department.[18]

Constructed on an empty lot north of Twelfth Street, the car shops were laid out by the PRR's Assistant Engineer on the main line, William H. Brown (1836-1910). A Civil War engineer, Brown later became the PRR's chief engineer in 1881, responsible for much of the right-of-way improvements initiated under Cassatt. The original car shop buildings were organized around the Foreman's office. To the north of the office was the 40-stall freight car repair house, providing the railroad with a capacity of constructing 500 new cars a month, or repairing 2000 cars. To the south of the office were located the original passenger car erecting shop, the blacksmith shop, and a combined machine and cabinet shop. Contemporary descriptions describe the advanced way these shops were fitted. Interchangeability is a frequent theme of these reports: in the blacksmith shop, all the work is brought to shape upon forming blocks, so that parts of every description can be duplicated and made interchangeable. Considerable time is also saved by this system, so that orders sent for repairs from different parts of the line can be fitted at once, and sent away with the certainty that they will come exactly into place.[19]

Immediately to the south of the original Car Shops, the railroad expanded the Car Shops in the late 1880s with a Paint Shop, Planing Mill, and Upholstery Shop.

1874-1899: Theodore N. Ely and the Establishment of the Juniata Shops

Thomson's death in 1874 caused a reorganization of the officers of the PRR. Among the changes were the elevation of the Frank Thomson from Superintendent of Motive Power and Machinery to General Manager.[20] In his place was appointed Theodore N. Ely (1846-1916). Graduating from RPI in 1866, he had joined the engineering staff of the Fort Pitt Foundry in Pittsburgh, where he gained valuable experience in the investigation of the quality of metals. Two years later he went to work for the PRR's leased road, the Pittsburgh, Fort Wayne & Chicago Railroad. Ely was responsible for many of the changes that took place in locomotive and passenger car construction over the next forty years. One of his earliest acts was the establishment of a Department of Tests, which in turn developed the necessary specifications for purchased materials. He introduced the piecework system to the Altoona Shops, and began the use of committees to study important questions. He was probably also responsible for initiating, if not designing, the Juniata Shops.[21]

During the 1870s, despite the financial depression which hit the country in the fall of 1873, the PRR made important additions to the Machine Shops. Indeed, these changes probably represented the last major improvements until Cassatt's modernization program thirty years later. These new buildings, together with the rest of the Altoona Shops, were described in detail by James Dredge, correspondent for the London journal, *Engineering*. In 1879 Dredge published a

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[18] 22nd PRR Annual Report (2/18/1869), p. 40.

[19] James Dredge, The Pennsylvania Railroad, Its Organization, Construction, and Management (London: Office of Engineering, 1879), p. 92.

[20] Frank Thomson (1841-1899); no relation to the late president, but later president himself, 1897-99.

[21] National Cyclopedia of American Biography, Vol. 32 (1945), pp. 220-221.

lengthy description of the Pennsylvania Railroad.[22] His account provided a detailed examination of all aspects of the railroad's organization, construction, and management. He gave particular attention to the Altoona shops, to which he devoted over 15,000 words and five plates of measured drawings. This record provides the best documentation for the Altoona shops at this period.

Three key buildings were completed during the 1870s: a new erecting shop, a new two-story machine shop parallel to it, and a new foundry. Of these, the most controversial was the longitudinal erecting shop. U.S. erecting shop practice hitherto--as well as subsequently--was to design erecting shops for transverse operation, arranging locomotive erecting pits perpendicular to the long, side walls. In the new Altoona shop, three lines of rails ran from end to end of the building. New locomotives were erected on the center track; repairs were made on the side tracks. Each track had room for seven engines.

Of all the debates about shop layout, the issue that evoked the most comment was the arrangement of tracks in the erecting shop. Because the erecting shop was where the various pieces came together, its arrangement in large part determined the arrangement of the entire shop facility and equipment. In 1896, a writer noted that the shop "has been the subject of frequent study and much criticism by railroad men ever since it has been erected."[23] Despite the disrepute in which the longitudinal shop was held elsewhere, he noted that "it would be very hard to find any one about Altoona who would advocate ... an erecting shop with transverse tracks and a transfer table." Altoona stuck with the longitudinal form until 1925.

One of the shop's innovative features, and indeed, what made the design possible, was the use of "rapid running cord cranes"--two 25-ton traveling cranes, powered by a cotton rope traveling at the rate of 5074 feet per minute (or approximately 84 feet per second). The cranes, possibly the earliest in the country, were manufactured by the English firm of Henry Wren & Co. of Leeds.[24] Below the floor of the shop, on each side of the center track were deep, paved pits extending the whole length of the building to store machinery and other engine parts. In the winter steam radiators placed in them warmed the building, with hot air rising through timber gratings.[25]

Like the erecting shop, the new machine shop also utilized a rope drive to power hoisting apparatus. Two stories in height, and 426' x 70'in plan, the shop was provided with a floor crane running on rails down the center of the shop. Motion was given to the crane by a rope running at high speed. Heavy machine tools were located toward the middle of the shop so as to be within reach of the crane, thus reducing the handling of heavy objects. Overhead belting, from two lines of shafting, provided the power to most of the machines in this shop.[26]

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[22] James Dredge, op. cit.

[23] "Altoona Shops of the Pennsylvania Railroad," American Engineer, Car Builder & Railroad Journal 70 (Sept. 1896), p. 203; "Altoona Erecting Shop No. 3," Railway Age 44 (20 September 1907), pp. 394-395.

[24] The traveling crane is thought to have been first used in England in 1833, by the inventor Johann Bodmer. It was slow to be picked up even in England, however. Early 20th-century American commentators on railroad practice link its use to the advent of electric power, which made it one of the most important pieces of equipment in the modern railroad shop. See Siegfried Giedion, Mechanization Takes Command (New York: W.W Norton & Co., Inc., 1969), p. 92; A.I. Totten, "The Evolution of the Railroad Shop," Railway Review (3 October 1914), pp. 408-411; also "Car Shops Old and New," Railway Age Gazette 48 (4 March 1910), pp. 467-468.

[25] Dredge, pp. 78-79.

[26] Dredge, pp. 76-78. 27; pp. 79-83, 167.

Construction of a new foundry brought the PRR closer to their goal of self-sufficiency. The main foundry, 250' x 100' in plan, was supplied by two cupola furnaces, each capable of melting ten tons of iron per hour, and furnished all the castings for both locomotives and cars. Wings attached to the foundry provided space for a brass foundry and a large wheel foundry. Hitherto, the railroad had purchased cast-iron wheels from a Philadelphia firm. The new wheel foundry, 138' x 35' in plan, was furnished with its own cupola furnaces. The casting floor was arranged for thirteen hydraulic cranes, each of which was surrounded by a circle of fifteen moulding flasks, for wheels up to 33" in diameter. A day's production amounted to 195 wheels.[27]

The interchangeability of parts was one of the key accomplishments of this period. James Dredge paid special attention to this aspect of the shops:

> The Pennsylvania Railroad Company have carried out completely their system of interchangeability of parts, and very many details of one engine are applicable to others of a different type. Thus, the maximum variation is only four different patterns of brass or iron castings for any given part, for the ten different classes of engines built.[28]

Standardization of parts also had implications for the systematic way in which operations were carried out by employees. Wrote one Boston columnist in 1879:

> [In the tool and standard sample shop] you notice again how thoroughly every part of this great system has been thought out. All gauges, templates, etc. are finished on standard measurements. No workman is allowed to set a pair of calipers for himself; they are made rigid. The motive for this is at once obvious. It ensures against error... It allows the employment of men less highly skilled than used to be the case in fine work, and it ensures also absolute interchangeability of parts in engines of the same class.[29]

As Superintendent of Motive Power, one of Ely's first acts in 1874 was to establish a Department of Tests. Initially concerned with physical testing, chemical testing was added in 1875. The testing department was designed to establish standard qualities for materials purchased from outside suppliers, as well as to test materials produced in Altoona. Testing machines designed to measure stresses in iron and steel were the earliest pieces of equipment acquired, allowing detailed experiments on wheel castings and car axles. Engine performance early became an important part of the work of the department. By 1896, the chemical laboratory had standard specifications for a variety of different metals, paints, oils, petroleum products, rubber, disinfectants, mineral wool, and other substances.[30]

Today, easily Ely's most visible achievement is the Juniata Shop complex. The construction of this complex was made necessary by the increasing locomotive size. Prior to 1880, most American locomotives were relatively small machines, rarely over 30 tons. Individual parts could be moved with handpower and swing cranes, blocks, jacks, and human muscles. But the increasing traffic after the Civil War, and the increasing engine size meant that by the 1890s this was no longer true. Power cranes and large overhead clearances were needed to clear a finished engine above its neighbor. On the Pennsylvania, the first real break came in 1885 with the first of a new design of Consolidation engines (Class R) built in Altoona. Steam pressure

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[27] Dredge pp. 79-83, 167.

[28] Dredge, p. 111.

[29] "Railroad Science, the Birth, Life and Death of a Locomotive," Boston Herald 2 August 1879, p. 4.

[30] Dredge, pp. 88-90; "Altoona Shops of the Pennsylvania Railroad," American Engineer, Car Builder & Railroad Journal 70 (Sept. 1896), pp 205-6.

was increased from 125 to 140 pounds per square inch. It was also the first engine to use the new Belpair boiler, and it became a highly successful design, built in large numbers. Its weight, however, was the first to break 50 tons, weighing 57.3 tons. The old Consolidation had been 48 tons, and as a result, the new engines could no longer be handled by the smaller overhead cranes. Commercial makers like Baldwin of Philadelphia, Cook Locomotive Works of Paterson, New Jersey, Pittsburgh, and a few others, opened new plants in this period. Juniata was part of this program.[S1]

At the Machine Shops, the longitudinal erecting shop had been laid out parallel to the Machine Shop. The Juniata layout capitalized on the success of this arrangement, placing the four principal shops, boiler, blacksmith, machine, and erecting shops in a parallel relationship. This arrangement made possible a smooth, orderly production flow. Raw material came in at one end of the boiler shop. As it passed along through the building it was flanged, punched, assembled, riveted, and passed out at the opposite end as a completed boiler. From there it was moved to the Erecting Shop, directly opposite. From the Blacksmith Shop, frames and forgings entered the Machine Shop, directly opposite it. The layout of the Machine Shop was such that the forgings were finished as they passed through it, without going over the same path twice, reaching a completed stage at the center of the building. Cylinders and other castings entered the Machine Shop from the opposite end, reaching a completed stage at the center of the building, where they met the frames and forgings. From the Machine Shop, parts went in company through an outside door to the Erecting Shop, where they were met by the boiler which had come in from the Boiler Shop.[S2]

The actual designer of the Juniata shops is not known. Ely may have been responsible, although Axel Vogt, appointed Mechanical Engineer at Altoona in 1887, about the time that the Juniata Shops were being designed, has also been suggested.[S3]

1899-1906: A.J. Cassatt and the Expansion of the PRR

The man who did the most to bring the Pennsylvania to its peak operating efficiency was Andrew J. Cassatt, the former Motive Power Superintendent. Between 1890 and 1902, PRR traffic had more than doubled and Cassatt faced the rapidly rising traffic needs with a massive overhaul of the road, completing the four-tracking of the main line and building a complete separate freight line over the Alleghenies, freeing the main line from the slower traffic. His most significant single achievement is widely recognized as the extension of the Pennsylvania into New York City via tunnels beneath the Hudson and East Rivers. By Cassatt's death in 1906, road investment had reached $172.9 million, a 128% increase over the figure ten years before.[S4]

Altoona shared in this expansion. All of Juniata's existing shops were expanded less than fifteen years after they were constructed, and a series of new shops, including a second blacksmith shop were constructed. At the Machine Shops, facilities had again reached their critical stage, with foundry activities woefully inadequate. The Eastern Roundhouse was

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[S1] Warner, p. S9; White, p. 11.

[S2] Frederic Blount Warren, "A Railroad University. Altoona and its Methods," Scientific American Supplement 63 (29 June 1907), p. 26324.

[S3] Vogt served as mechanical engineer for more than thirty years, improving motive power efficiency, and refining the design of locomotive details.

[S4] Burgess, pp. 463, 507.

demolished in 1905, and in its place was constructed Erecting Shop No. 3, built between 1905 and 1907. It retained the successful longitudinal design of the 1875 erecting shop, together with the floor pits and overhead cranes. In addition, the railroad introduced electric jib cranes, carried on overhead runways.[35] In part to replace the Eastern Roundhouse, the railroad built at East Altoona what was reputedly the largest roundhouse in the world to service the large number of freight engines then passing through Altoona. With a diameter of 395', the building contained fifty-two locomotive stalls, 90' deep.[36]

Crowding at the Machine Shops also forced the wheel foundry to relocate, and in 1904 the company began construction of two foundries in South Altoona, complete with its own machine and pattern shops. The wheel foundry was the largest and the most important of the six main buildings built in South Altoona, with a capacity of 900 wheels per day, more than three times the capacity of the old foundry. It was made up of three sections, each containing a pair of cupolas, and twelve 25-wheel molding floors, arranged in three bays. Opposite the wheel foundry was the gray-iron foundry, designed chiefly to produce castings for car and locomotive repairs, and for new engines built at Juniata. Also constructed at this time was an 161' x 89' power house, supplying not only steam, but compressed air for foundry purposes, and water at 500 pounds pressure to operate cupola elevators, wheel breakers, and hot metal reservoirs. To supply the foundries, the railroad constructed a single-story pattern shop (193' x 91') and adjacent three-story pattern storehouse (180' x 91'). A small single-story machine shop, 110' x 60' in plan, was located between the two foundries, and a small office located at the northeast corner of the lot.[37]

1906-1925: Peak & Consolidation: James McCrea and Samuel Rea

After Cassatt's death, the railroad reached its peak, as the financial depression of 1907 brought a downturn in earnings. Although James McCrea (1848-1913) was able to continue most of Cassatt's programs, including the opening of Pennsylvania Station in 1910, few new programs were begun. Among them, however, was the steel passenger car, first introduced in June 1906. The new steel car shop completed soon after rapidly shifted the emphasis of car construction away from the wooden cars that had been standard up to that time. The new all-steel car design known as "Class P70" introduced in December 1907 became the basic PRR design for many years.[38]

McCrea's successor was Samuel Rea (1855-1929), the engineer responsible for the New York tunnels and station construction, who had been made Vice President and ranking officer of the company by Cassatt. U.S. railroad mileage reached its peak in 1916; for the Pennsylvania, it climbed slowly a few years longer, until in 1920 the road reached its maximum with 11,107 miles. The most well known among Rea's accomplishments during his term was the construction of the Hell Gate Bridge and a through route to New England, which opened in 1917. Traffic continued to increase until the mid 1920s, when the growing impact of automobile and truck traffic began to have its effect. Heavier locomotives continued to be built, the most famous of which were the K-4s Pacific Class Locomotives, introduced in 1914. This locomotive class was the dominant passenger engine on the non-electrified lines until after World War II. Between 1914 and 1928, the Juniata Shops constructed 350 engines of this class.[39]

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[35]"Altoona Erecting Shop No. 3," Railway Age, 44 (20 September 1907), p. 394.

[36]"The East Altoona Freight Termiol of the Pennsylvania Railroad," The Railway Age, 19 January 1906, pp. 86-97.; see entry of East Altoona Freight Terminal in the Transportation Section.

[37]"Foundries of the Pennsylvania Railroad at Altoona," The Railway and Engineering Review, 45 (10 June 1905), pp. 422-426; "The New Car-Wheel Foundry of the Pennsylvania R.R.," The Engineering Record, 51 (8 April 1905), pp. 396-399; "The New Wheel Foundry of the Peonsylvania Railroad at Altoona," The Railroad Gazette, 38 (17 March 1905), pp. 226-231.

[38]Burgess, pp. 760-761.

[39]Burgess, p. 534.

Another major event of 1914 was the completion of the new Test Department building. At the St. Louis Exposition in 1904, the PRR had exhibited a unique locomotive testing machine--the only equipment in the country capable of testing a locomotive in motion on a stationary bed. After the fair, the equipment was removed to Altoona where in 1914 it was housed in a new three-story reinforced concrete testing plant, 154' x 47' in plan. The new building nearly tripled the quarters available for the department, which by this time was issuing over 60,000 reports of material tests a year.[40]

Increasing engine size brought with it the need to improve repair shop facilities to handle larger engines. As a result, the number of shops for general repairs was cut to ten locations during this period.[41] Heavy repair work, in addition to locomotive construction, was concentrated at Juniata, where in 1925, the company built the 5.5 acre Erecting and Machine Shop, together with an adjacent warehouse and office. Contemporary accounts described it as the largest and most complete railroad-owned erecting shop in the country. Unlike the earlier longitudinal shops, the new shop was a transverse shop. It combined erecting facilities in two outer bays, with machine shop facilities in two inner bays, thus reversing the deliberate separation of functions into different buildings which Juniata had originally represented. The shop's intended role in the PRR system is summarized by the figures for 1926 shortly after the new facility opened: three quarters of the PRR's 7300 operating locomotives had been built at Juniata, which, together with the Machine Shops, was responsible for half the repaired locomotives in the system.[42] Here, in the 1930s, as electrification of the PRR's eastern lines progressed, would also be built many of the company's celebrated GG1 electric locomotives.

Although auxiliary buildings have continued to be built at Juniata, the Erecting and Machine Shop was the last major building constructed. A serious fire destroyed a large part of the Machine Shop complex in December 1931. What remained of the former Machine Shops became the Twelfth Street Car Shops in 1938, as all steam locomotive repairs were shifted to Juniata. Functions shifted at South Altoona as well: after the fire at the Machine Shops, the brass foundry moved into the former wheel foundry. To repair locomotive tenders, a new tank shop was constructed in 1927, adjacent to the steel car shops. Although the last locomotive was constructed in 1946, the Altoona Works remained in full operation as a car and locomotive maintenance facility until the 1960s, when portions of the car and machine shops were sold. Despite the changes in ownership of the railroad itself, today the Juniata shops, as the railroad's principal repair facility, under Conrail, have a much-expanded service territory. At South Altoona, the wheel foundry has been adapted as a major distribution facility for the company. Conrail has also retained a presence at the Machine Shops, where the office was in use until 1984. The northern portion of the car shops now serves as a part of the Juniata operation.

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[40] C.D. Young, "The Test Department of the Pennsylvania Railroad," Railway Age Gazette, 59 (2 July 1915), pp. 6-11.

[41] The ten shops were: Altoona Machine Shops, Trenton, Wilmington, Renova, Canton, Olean, Dennison, Columbus, Fort Wayne, and Logansport See Railway Age 79 (21 November 1925), p. 936.

[42] W.W. Baxter, "Pennsylvania Reconstructs Juniata Shops," Railway Review, 30 January 1926, p. 226.